Engineering Controls for Tuberculosis: Upper-Room Ultraviolet Germicidal Irradiation Guidelines

NIOSH Response to External Peer Reviewers comments

The Alert was reviewed by external reviewers from academia, government, industry, and professional organizations. No major structural changes to the document were required to address the external reviewers' comments. Most of the reviewers suggested editorial and content modifications to improve clarity and accuracy. The NIOSH authors found these comments to be very useful and, in most instances, the suggestions were incorporated into the document.

Specific Questions (as set forth in the "Charge to Peer Reviewers")
Questions #1 and #2 - A well-designed upper-room UVGI system should be effective if designed to provide an average UVGI irradiance in the upper-irradiated zone in the range of 30 to 50 $\mu W/cm^2$ provided the other elements stipulated in the guidelines are met. To simplify the installation process, two additional "rules of thumb" (guidelines) are provided in the document for installing UVGI systems. These guidelines are based on the required UV lamp wattage for a system. Considering all parameters, the installation of UVGI fixtures in rooms with approximately 8-ft (2.44 m) ceilings that provide (a) 1.87 UV-C watts (W) per m^2 (0.17 UV-C W per ft^2) of floor space or (b) 6 UV-C W per m^3 (0.18 UV-C W per ft^3) in the upper-UVGI zone should be effective in killing or inactivating airborne mycobacteria.

Question # 3 - Methods for measuring UVGI irradiance in the lower occupied portion of a room and the upper air where droplet nuclei are irradiated are provided in the technical document. Both methods are cumbersome and require that a qualified person make the measurements. A method for spot measurements provided by one of the reviewers was incorporated into the document. It is noted in the technical document that mathematical modeling or computational fluid dynamics can be used to estimate the upper-room UVGI provided by several fixtures prior to installation. Modeling and chemical actinometry are described in Appendix B as research tools. Additional research needs to be done in these areas, and this was noted in the research needs.

Question # 4 - Based on the reviewers' comments, the technical document now states "lamps should be changed on a fixed schedule based on the lamp manufacturers' recommendation. If feasible, group relamping should be done on a yearly basis. The lamp or ballast should be replaced if the lamp stops glowing or flickers."

Question # 5 - The technical document provides guidance on air mixing considering a number of variables (e.g., temperature, mechanical ventilation, placement of supply diffusers and exhaust grills) and evaluating air mixing. Most rooms or areas with installed supply diffusers and exhaust grills should have adequate air mixing to insure that droplet nuclei are exposed to UVGI in the upper room. In those circumstances where air stagnation exists, the use of mixing fans to facilitate air mixing between the upper and lower room areas seems appropriate. However, fans may affect negative pressure in AII rooms or areas and operating rooms. Additional guidance is being requested from the National Center for Infectious Diseases for incorporating into future information on this specific topic.

General Questions
Many of the reviewers' comments were incorporated into the technical document or added as research needs. Several reviewers believe the CDC/NIOSH maximum recommended exposure level for people in the lower room limits the UVGI level in the upper room thereby decreasing the effectiveness of upper-room UVGI systems. The guidance provided in this area in the technical document is similar to that provided in the 2005 CDC TB Guidelines. The reviewers concerns were noted in the "Exposure Guideline" section of the technical document.